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ABSTRACT

A project to develop special training materials to introduce college teachers to the math-language approach is reported. The materials link language learning techniques to mathematics concept formation and are intended for teachers of limited-English-proficient (LEP) students. Specialists in both fields produced a three-part training package consisting of an instructor's guide and a video program, to be used as an introduction to and rationale for using the approach, and as a general blueprint for a text and workbook produced by the Center for Applied Linguistics and entitled "English Skills for Algebra." The report describes activities undertaken in developing the materials and assessing their effectiveness as compared to the conventional workshop method of teacher training. Results of interviews and surveys indicate that the materials provide the necessary classroom guidance for instructors to address the needs of LEP students without the need for workshop attendance. It is also concluded that the training materials will meet their objective of developing appreciation for interdisciplinary cooperation and make the approach more accessible to both math and English-as-a-Second-Language (ESL) teachers. The materials stated as appended (instructor's guide, textbook, video programs, a bulletin, workshop agendas, and ESL language objectives) are not included. (MSE)

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Miami-Dade Community College
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300 NE 2nd Avenue
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"PREPARING COLLEGE TEACHERS TO INTEGRATE MATH AND LANGUAGE INSTRUCTION"

Grant No: G-008730483

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"PREPARING COLLEGE TEACHERS TO INTEGRATE
MATH AND LANGUAGE INSTRUCTION"
(Grant # G008730483)

Project Summary

"Preparing College Teachers to Integrate Math and Language Instruction" was designed to give continuity to the work of many researchers and teachers who are investigating and developing methods to link language-learning techniques to mathematical concept-formation among limited English proficiency students. For years research has indicated that the language factor is a major obstacle to the acquisition of math skills and basic understanding of math concepts, a fact which is exacerbated with minority students and is thus closely related to minority underrepresentation in institutions of higher learning. Work has been going on at the Center for Applied Linguistics (CAL) to produce methods and materials to attack this deficiency in the acquisition of mathematical skills. The Miami-Dade-FIPSE project has taken the result of this pioneering work and made it more widely available by developing special training materials to introduce to many what has become known as the math-language approach and to facilitate the training (and self-training) of college instructors to implement this essential approach in their classrooms. Math and language specialists were brought together and developed a three-part training package consisting of an instructor's guide and a video program to serve as an introduction to and a rationale for using the math-language approach and as a general blueprint for using CAL's book, *English Skills for Algebra* (Center for Applied Linguistics/Prentice-Hall, Englewood Cliffs, N.J., 1989). The project's goal is to create an awareness of the roots of the problem and also to improve access to the math-language approach as a possible solution to such problems.

PROJECT: "Preparing College Teachers to Integrate Math and Language Instruction"

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PRODUCTS: Book: *Instructor's Guide for "English Skills for Algebra"*
Videos: *Introduction to the Math-Language Approach* and,
Using English Skills for Algebra in Your Classroom,

EXECUTIVE SUMMARY

"PREPARING COLLEGE TEACHERS TO INTEGRATE MATH AND LANGUAGE INSTRUCTION"

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PROJECT OVERVIEW

In 1983, publication of a report by the National Commission on Excellence, entitled *A Nation at Risk*, spurred massive efforts to heal some of the ills affecting our country's educational system. Among those ills, and comprising one of the central themes of the report, was the particularly poor performance of our nation's students in mathematics- and science-related areas, as well as plummeting enrollments in these fields in postsecondary institutions. Growing bodies of research have shown high positive correlations between mathematics achievement and second language ability. On the basis of these and other findings, combined with statistical evidence of poor performance by limited English proficient math students and testimony offered by their instructors, it was clear that further research into the language barriers to successful mathematics problem solving was needed. More specifically, it was deemed necessary to develop a linguistic approach and materials to enable students to acquire and use the language of mathematics more easily. This called for a collaborative effort by mathematics and linguistics experts. One of the first major steps in this direction was the work of the Center for Applied Linguistics (CAL) in researching and developing materials for a math-language approach with the publication of their *English Skills for Algebra*..

Building on current research and CAL's pioneering work in the field, the Center for Business and Industry of Miami-Dade Community College, Wolfson Campus, in close cooperation with the English Language Institute and the Department of Arts and Sciences at Mitchell Wolfson Campus and the InterAmerican Center of Miami–Dade, was awarded funding by the Fund for the Improvement of Postsecondary Education to conduct the following activities:

- To develop a comprehensive instructor's guide to accompany the text/workbook, *English Skills for Algebra* developed earlier by the Center for

Applied Linguistics. This guidebook was designed to provide the necessary guidance to algebra and ESL instructors to enable them to incorporate English language skills training into algebra classes and basic math concepts into ESL classes without the need for each instructor to attend training workshops or to employ specialists to implement these materials.

- To produce a video presentation (2 programs) designed to introduce an algebra instructor and ESL instructor to the concepts incorporated in the text, *English Skills for Algebra*, and to the use of the *Instructor's Guide*. The first program presents an overview of the problems of limited English proficiency (LEP) students learning mathematics in their second language as well as a rationale for using the math-language approach; this video can also be a means of dissemination for the approach and the Project. The second video provides visual references to specific classroom applications of the approach as well as a discussion of selected topics by the project's senior math-language consultant.

- To assess the applicability of a package consisting of the above videos and instructor's guide to train math and ESL teachers in the use of *English Skills for Algebra*. The video/instructor's guide package was comparable to 20 hours of workshop training that, up to the present time, had been the only method of training available. The object of the comparison was to determine if the video/guide combination could be just as effective as the workshop training.

Background and Origins

A particularly alarming trend in American schools is the underachievement of students in mathematics-related education. This underachievement is particularly apparent among minority students and is thus closely related to minority underrepresentation in institutions of higher learning. Mounting evidence strongly suggests a language factor as a major obstacle to the acquisition of math skills and basic understanding of math concepts (Halliday, 1974; Cossio, 1978; Cuevas & Llabre, 1981; Dawe 1983; Coffland & Cuevas, 1979). The Center for Applied Linguistics (CAL), with the support of FIPSE, developed a series of language development activities designed to be more responsive to the specific needs of limited English speaking students, enabling them to acquire the linguistic and cognitive skills essential to understanding and applying mathematical concepts.

In order to make CAL's pioneering work more widely available, the Center for Business and Industry of Miami-Dade Community College, Wolfson Campus (in close cooperation with the English Language Institute, the Department of Arts and Sciences at the Wolfson Campus, and both the Bilingual Division and the Department of Arts and Sciences at the Inter-American Center of Miami–Dade) was awarded a FIPSE Grant to develop and test the effectiveness of a comprehensive instructor's guide companion for *English Skills for Algebra* and to produce a video presentation, both to prepare instructors in the background and application of the CAL text/workbook, *English Skills for Algebra*.

PURPOSE

By providing a low-cost alternative to time- and resource-consuming workshops, the video/guide package makes the materials more easily accessible to teachers who otherwise would not have known about the math-language approach. It is believed that the options presented in the *Guide* for implementing this approach will inspire needed interdepartmental dialogue on campuses around the nation. Also, increased usage of the innovative CAL materials should provide timely input to the national debate on educational quality in general, and on improvements to math/science and bilingual education in particular. There has also been a specific local impact since newly-trained instructors have been taught to apply this innovative approach in the Miami metropolitan area where there is an urgent need to address the lack of mathematics and linguistic skills among a significant proportion of the community.

PROJECT DESCRIPTION

The project was realized by the close collaboration between renowned math-language experts from the Center for Applied Linguistics in Washington, Miami-Dade Community College (M-DCC) and the University of Miami and was managed through the Center for Business and Industry, M-DCC. Written materials were prepared, and teacher training workshops were given by both M-DCC and CAL personnel; the two training videos were developed by M-DCC's North Campus Media Production Center with scripting and editing support provided by project math-language specialists.

The project basically developed in four stages: administration and planning, production of teacher-training materials, the pilot program with training and application of materials, and, finally, evaluation and revision.

The first stage of the project was occupied with putting together the professional team, meeting with them and setting out the guidelines for the administration of the project itself, for the research and writing of the instructor's guide, preparations for the videos, and for preliminary institutional contacts to arrange the upcoming pilot program.

The second stage involved the production of the training materials themselves (writing, editing, revision and desktop publishing of the *Guide*, plus scripting, production, and post-production of twenty-five– and forty-minute videos) and was certainly the most intensive. The *Instructor's Guide* for *English Skills for Algebra* was designed to introduce both math and ESL instructors to the ideas of the emerging "math-language approach" and to provide a general blueprint for using *English Skills for Algebra* in algebra and ESL classrooms. It provides suggestions on how teachers might select appropriate supplemental math-language activities from the original materials produced by CAL and how to integrate these activities into their regular courses of study.

The *Guide* is only one of the three parts of a total training package for using *English Skills for Algebra*. Two videos complete the package. The first video,

Introduction to the Math-Language Approach, presents an introduction to and a rationale for using a math-language approach. Ideally this video should be seen first, even before reading the *Instructor's Guide*.

The second video, *Using English Skills for Algebra in Your Classroom*, shows algebra and ESL classroom demonstrations of activities from *English Skills for Algebra*. The second video can be used as often as needed as a visual reference to accompany the unit-by-unit suggestions given in the *Instructor's Guide*.

During the third stage, our pilot program, the materials produced in the grant were first applied. Math and language instructors, selected from Miami-Dade and Barry University, were divided into groups, each of which was trained in the background, philosophy, methodology, and application of the math-language approach. One group used the new training program and materials (*Instructor's Guide* and videos), while the other was given the traditional workshop training.

The final stage of the project tied things together: evaluating the results of the training package and revision of materials based on feedback from the pilot program. For the purpose of disseminating the work of the FIPSE project, a newsletter, *The Math-Language Bulletin*, was produced to explain the math-language concept and describe the project, its development and the availability of the new materials.

PROJECT RESULTS

Both training groups have shown an understanding of the basic tenets of the math-language orientation and have successfully applied the CAL materials in their classrooms according to their own students' backgrounds and needs. Both groups were able to select and effectively utilize math-language materials appropriate to their situations.

SUMMARY AND CONCLUSIONS

Interviews, questionnaires, and surveys indicate that the materials developed under the auspices of FIPSE sponsorship have provided the necessary classroom guidance to allow instructors to address the needs of their limited English proficiency students, without the need for each instructor to attend training workshops. A consideration of the new training materials was to develop (as would be done at the workshops) an awareness for interdisciplinary cooperation: we had to broach the problem of resistance of instructors from one discipline to incorporate methods or content from another, and to make it clear that success in improving math-language concept-formation might likely require active dialogue between the disciplines. It is believed that these new training materials will make the the math-language approach and the supplemental language development activities designed by CAL more accessible to algebra and ESL instructors throughout the United States.

APPENDICES

- the *Instructor's Guide to English Skills for Algebra*
- a copy of CAL's textbook *English Skills for Algebra*

- Video programs #1 and #2
- the *Math-Language Bulletin*
- agendas from workshops
- ESL language objectives

FIPSE PROJECT FINAL REPORT

"PREPARING COLLEGE TEACHERS TO INTEGRATE MATH AND LANGUAGE INSTRUCTION"

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A) PROJECT OVERVIEW

Addressing the growing national concern over the underachievement of students in mathematics-related education, the Center for Applied Linguistics (CAL), with FIPSE grants (1985-1987), developed a series of supplemental language development activities. These activities were designed to enable limited English proficiency (LEP) students to acquire the linguistic and cognitive skills essential to understanding and applying mathematical concepts.

In order to make this pioneering work more widely available, the Center for Business and Industry of Miami-Dade Community College developed (with CAL) and evaluated training materials to accompany the CAL text/workbook, *English Skills for Algebra*.. These training materials consist of an instructor's guide and two video programs which enable instructors to incorporate an algebra component into the existing required ESL coursework and, conversely, a linguistic dimension into the existing algebra curriculum.

The *Instructor's Guide* for *English Skills for Algebra* introduces both math and ESL instructors to the tenets of the emerging "math-language approach." It provides suggestions on how they might select appropriate supplemental math-language activities from the CAL book and how to integrate these activities into their regular courses of study. The *Guide* has a glossary of algebra terminology with traditional mathematical definitions alongside more "user-friendly" explanations.

Two videos accompany the *Instructor's Guide to English Skills for Algebra*. The first presents an introduction and a rationale for using a math-language approach to learning. The second video serves as a visual reference to the guide. It shows algebra and ESL classroom demonstrations of activities from the textbook, *English Skills for Algebra*.

The materials are designed to provide the necessary guidance without the need for each instructor to attend training workshops. Through interviews,

questionnaires, and surveys the project has examined the adequacy and efficiency of the new materials.

The first phase of the Miami-Dade Community College–FIPSE project, "Preparing College Teachers to Integrate Math and Language Instruction", was directed toward developing a comprehensive instructor's guide to accompany CAL's text/workbook, *English Skills for Algebra* and toward producing a companion video presentation designed to introduce an algebra instructor and ESL instructor to the concepts incorporated in the aforementioned text. The second phase of the project focused on pilot-testing the materials in the classroom. The following provides an overview of the project's development.

The Instructor's Guide. The primary function of the *Guide* is to train instructors in the use of *English Skills for Algebra* as a curriculum resource. Other, but equally important, roles for the *Guide* are to clarify and illustrate the math-language concept, to provide keys to the interdisciplinary nature of the approach, and to offer alternative "itineraries" through the material to better enable teachers to adapt the approach to their particular discipline and situation. Detailed discussion on these and other issues related to the development of the *Guide* can be found in the "Project Descriptions" section in Part D of this report. The *Guide* was written in two parallel parts: one addressed to the algebra instructor (left page); the other to the ESL instructor (right page).

The Video. In order to more completely parallel the experience and knowledge normally gained at the workshops, it was decided to produce two, rather than one, video. The first video deals with the math-language conceptual presentation and introductory lessons from the early units; the second aids instructors in visualizing and applying the program as shown in the CAL textbook and explained in the *Instructor's Guide.*

The Pilot Program. The final phase of the program assessed the applicability of the package consisting of the videos and instructor's guide to train math and ESL teachers in the use of *English Skills for Algebra.* The video/instructor's guide package was compared to the 20 hours of workshop training. The outcome of the project indicates that the video/guide combination can be a viable substitute procedure for the workshop training.

B) PURPOSE

The text, *English Skills for Algebra,* though it has been shown to be effective, has been difficult to introduce into the classroom. Mathematics instructors do not immediately perceive the importance of teaching language skills to their students, and English instructors often feel inadequate to the task of teaching mathematical concepts. Nor do they readily perceive the *supplementary* nature of its application in the curriculum. In the past, it has been necessary to bring these instructors together into a workshop setting wherein they have been encouraged and explicitly trained to use these materials. This training has typically taken at least twenty-five hours or more over five workshop periods. The goal of this project was to provide a means of introducing instructors, both ESL and algebra,

to the math-language teaching approach without the necessity of instructors attending long workshops, and to provide a means of guiding them in the classroom use of the text materials.

One of the problems that the Center for Applied Linguistics encounters with its materials is that the manner in which the algebra teachers and the ESL teachers implement *English Skills for Algebra* in their classrooms and the focus placed on different components within the various units, differ significantly. Since, for example the primary focus in the ESL classroom is on learning English, it is not surprising that ESL instructors tend to focus on vocabulary, grammar and syntax while de-emphasizing cognitive and problem-solving skills. Algebra instructors on the other hand, place a primary emphasis on more complex algebraic operations since their major instructional goal is to teach algebra. Our project sought to address the need for providing distinct methodologies for use by the ESL teacher who wishes to integrate mathematics-based activities into the classroom as well as for the mathematics teacher who desires to incorporate a "language" of math component into the algebra classroom.

The *Instructor's Guide* facilitates the use of CAL's promising curricular innovation, integrating math and language instruction, by leading the ESL instructor through the maze of mathematical jargon and concepts. At the same time it offers the algebra teacher, who is unfamiliar with the language difficulties often experienced by students, various strategies for incorporating a meaningful linguistic component into the algebra classroom.

C) BACKGROUND AND ORIGINS

In 1983, publication of a report by the National Commission on Excellence, entitled *A Nation at Risk*, spurred massive efforts to heal some of the ills affecting our country's educational system. Among those ills, and comprising one of the central themes of the report, was the particularly poor performance of our nation's students in mathematics- and science-related areas, as well as plummeting enrollments in these fields in postsecondary institutions.

Closer scrutiny of the issue revealed an equally alarming corollary trend, the underachievement and very limited enrollment of minority students in mathematics-related education. According to a report by the U.S. Department of Commerce in 1981, Hispanics comprised a mere 3.7 percent of full-time undergraduates and only 2.2 percent of graduate students in American postsecondary institutions. As a consequence, Hispanics and other minorities are seriously underrepresented in technical and mathematics-related careers and professions.

It has been discovered that one of the major factors in poor math performance by Hispanics and other minorities is the language barrier, the inability of these students to read and comprehend English. Studies show that Asian students, a group not traditionally associated with poor math performance, are also experiencing difficulties with math word problems.

Research. A large and growing body of research supports the correlation between language skills and math performance. One of the earliest studies in this area, conducted by L. R. Aiken, Jr. in 1972, demonstrated high positive correlations between mathematics achievement and reading ability of native English speakers. Research by M. G. Cossio in 1978 confirmed a positive correlation between math achievement and second language ability; and a study by R. Duran in 1979 pointed to a correlation between reading comprehension skills and deductive reasoning ability.

In 1983, Burns found a strong, positive correlation between the English language proficiency of Hispanic college students enrolled in technical courses and their ability to perform mathematical tasks in English. This correlation did not exist for the language majority students who were also tested in the study. Burns explained that the Hispanic students had not yet crossed a "technical threshold," the minimal level of linguistic competence needed to participate effectively in cognitively demanding, academic tasks.

Other studies have shown that many language minority students, although possessing oral fluency in English, experience great difficulty in performing academic and technical tasks in the language. This would suggest that a technical threshold reflects the cognitive and linguistic demands of mathematics and technical fields.

The math register. Only very recently have researchers begun to identify the language skills comprising a technical threshold in mathematics. Halliday began working toward this end in 1975 with his description of a mathematics language register, a vocabulary and syntactic components used particularly for mathematics. He delineated this register into four basic areas: 1) natural language words reinterpreted in the context of mathematics, such as *set, point, field;* 2) terms created from combinations of natural language words, such as *feedback* and *output;* 3) terms formed from elements of Latin and Greek words; and 4) locutions, such as *square of the hypotenuse* and *least common denominator*.

Additional components and infrastructures of this "language of mathematics" have been identified as particularly problematic for the non-native speaker, such as comparative structures and the frequent use of the passive voice and prepositional phrases in mathematics operations. These features are difficult enough for native English speakers to grasp and utilize in solving mathematical problems. The difficulty is exacerbated when English is the second language of the student.

On the basis of these findings, combined with statistical evidence of poor performance by limited English proficient math students and testimony offered by their instructors, it was clear that further research into the language barriers to successful mathematics problem solving was needed. More specifically, it was deemed necessary to develop a linguistic approach and materials to enable students to acquire and use the mathematics register more easily. This called for a collaborative effort by mathematics and linguistics experts.

In such an ethnically and linguistically diverse community as the greater Miami area, there exists a particular urgency in seeking solutions to the critical problems associated with language competency and mathematical ability among Hispanic students as well as other large immigrant groups whose native languages are other than English. Of a total population of 1,796,000 in Dade County, 367,000 of its residents are classified as black and 768,000 are Hispanics, the two minorities constituting 63.2 percent of the county's entire population (Dade County Planning Department, 1985). Miami-Dade Community College (MDCC) also counts large numbers of minority students enrolled in its courses. Nearly half of its students are Hispanic (48.6%) and 46% of its students' native languages are other than English (Institutional Research, MDCC, 1986). Additionally, MDCC enrolled 4316 international students from 90 nations in academic year 1984-1985, the largest number of foreign students in any postsecondary institution in the U.S. (Chronicle of Higher Education, October 9, 1985). A recent study of first-time-in-college students conducted at Miami-Dade reveals that 42% of Hispanic students and 64% of black students fail to meet the minimal score required on the Multiple Assessment Programs and Services Reading Test (MAPS is the entry-level placement test utilized by MDCC), compared to the national average of only 29%. Moreover, 44% of Hispanic students and 62% of black students fail to attain the minimal passing score of 14 on the elementary algebra section of the MAPS and are remanded to pursue college preparatory coursework. These statistics underscore the need to introduce innovative instructional methods and materials in mathematics that are more responsive to the specific needs of limited English speaking students.

Previous related grants. Building on the aforementioned corpus of research and supported through funding provided by the Fund for the Improvement of Postsecondary Education (FIPSE), the Center for Applied Linguistics (CAL) in conjunction with Metropolitan State College, Northern Virginia Community College and Miami-Dade Community College, developed a series of language development activities designed to enable students to acquire the language and cognitive skills essential to understanding and applying mathematical concepts.

The result of this collaborative venture was the development of a text-book/workbook, *English Skills for Algebra,* (a copy of the text is included in the Appendix) that incorporates pre-algebra/algebra material into language instruction. This integrative language skills approach to math instruction has been designed to encourage active group participation in order to stimulate and maintain student interest in mathematics. The *English Skills for Algebra* series, consists of five instructional units covering five basic topics in introductory algebra:

Numerical and Algebraic Expressions
Equations and Inequalities
The Language of Word Problems
Definitions and Properties

These units enable algebra instructors to implement a language skills approach to teaching algebra and allow ESL teachers to provide math content for English instruction. The approach upon which the five units were written integrates language into algebra instruction by providing students with practice in manipulating the special terminology and unique syntactical structures used in mathematics through reading, writing, listening and speaking activities in English. By using English as the medium through which students can learn the specialized language of mathematics and algebra, the philosophy underlying *English Skills for Algebra* primarily focuses on the complex set of processes required to translate numbers and other mathematical symbols into words and from words into mathematical symbols. The math-language approach is designed to enable students to acquire a mastery of the language skills necessary to grapple with numerical and algebraic expressions, equations, and inequalities. A basic understanding of the language of mathematics is a fundamental prerequisite in the application and acquisition of introductory-level algebraic concepts not only for limited English proficiency students, but native English speakers as well. The Limited English Proficiency (LEP) student however, as Dr. Cuevas has stressed in his research, is faced with the additional task of learning not only the academic English required to understand textbooks, but also the "social" English necessary to adjust and function in American society. *English Skills for Algebra* seeks to teach the underlying processes associated with learning algebra rather than the general mechanics of problem solving or learning math-related vocabulary. The text has been designed to enable the student to go beyond this level to discover why and how these mechanics work. The units are the vehicle through which such an understanding can be achieved.

Under a separate grant awarded by the Department of Education, under the Secretary's Discretionary Fund in 1986-1987, the Center for Applied Linguistics was able to field-test the materials in a training project for Junior High algebra and ESL teachers from Virginia, Maryland, and the District of Columbia. Teacher responses to the language approach and the materials were very favorable. Both the algebra and math teachers indicated that they believed that the math-language approach found in *English Skills for Algebra* helped their students learn mathematics. One math teacher commented for example that "The language is the key to solving basic algebra skills. Students exposed to these materials are now showing a better understanding of the simple algebra skills taught." An English instructor also found that the materials helped ESL students learn English, "The word problems as well as the section on equations fit very nicely into language learning. The units were very good in terms of making the students read the problems and brought about some language analysis and application." These anecdotal materials provide evidence to support the implications of the vast amount of research which has been done on integrating math and language instruction: namely, the critical need that exists to improve mathematics performance for limited English proficiency students through innovative, effective curricula.

D) PROJECT DESCRIPTION

While the project, as initially conceived, would occur in two phases, in practice each phase had two parts, leading really to a four-stage development: 1) administration, preparation, and planning; 2) writing and editing of the *Instructor's Guide*, "Math Notes" and "Glossary Applications" as well as scripting, production and post-production of two videos based on the *Guide*; 3) the Pilot Program with regularly scheduled workshops, distribution and utilization of *Guide* and videos and classroom application of the the math-language approach; and 4) project evaluation and revision of materials.

Upon identifying and assembling a professional team, the ensuing path was followed as the project took shape: gathering and interpreting all research and evaluative materials related to the mathematics/language teaching approach in general and the classroom utilization of *English Skills for Algebra* in particular; general project organization, planning, and refinement by project staff; finalization of administrative details related to project management such as setting up project budget and bookkeeping procedures, completion and implementation of subcontracts related to the project, explanation and outline of billing procedures for project consultants, etc.; the selection, hiring and orientation of project staff; final definition of format for the instructor's guide; extensive discussion, planning, and final decision on format for video concept; discussion and consensus on evaluation design to be employed to assess how well we will have met our objectives by project end; writing, editing and finalizing the *Instructor's Guide*; developing and editing the scripts for the videos; and finally, pre- and post-production of the videos.

Stage 1—research and preparation. During the first stage of the project, the initial efforts were directed toward gathering and interpreting all research and evaluative materials related to the math-language teaching approach in general and the classroom utilization of *English Skills for Algebra* in particular. The material served as the basis for the development of the instructor's guide and the video introduction to the mathematics/language teaching approach.

Much discussion went on referent to the salient qualities of the workshop training session employed in the past by CAL and how to incorporate similar functions into the instructor's guide. Using feedback from previous try-outs of *English Skills for Algebra* by CAL as indicative of potential areas of difficulty or confusion, goals that were set for the *Guide* included:

- create an awareness of the role of language in mathematics; point out some of the linguistic problems in mathematics learning and potential remedies
- create an awareness of the role linguistic problems apparently play in the low success rates of minority and limited English proficiency students in math- and science-related activities
- introduce and explain the historical background, the research and basic notions of the math-language approach

- introduce the concepts of the math register
- offer a review of basic math and algebra terminology for ESL instructors through the special glossary and the "Math Notes."
- encourage interdepartmental cooperation to more coherently work on the problems
- introduce the content and format of the exercises in the CAL text/workbook *English Skills for Algebra*
- illustrate language-learning techniques and their application in the math class (e.g., paired students, "think-aloud" activities, word-symbol "translations", vocabulary review, listening exercises, etc.)
- explain and emphasize the *supplementary* nature of the *English Skills for Algebra* program
- indicate how to make best use of the CAL materials according to differing student needs, levels, and backgrounds
- suggest how to select materials
- suggest strategies on how to deal with "mixed" classrooms (those with varied levels of math and/or language backgrounds and preparation)
- indicate how to use the exercises as an informal diagnostic tool to assess student needs in the math-language problem area
- suggest ways to choose and incorporate exercises and techniques into already tight syllabi
- encourage the instructors (and hopefully departments) to create *new* activities based on the techniques and tenets espoused in the *English Skills for Algebra* approach
- produce a "user-friendly" revision of the *English Skills for Algebra* Glossary to aid instructors in distinguishing pertinent terminology and in leading their students in glossary-related activities
- provide ESL instructors with a very basic review of relevant mathematical concepts (math notes)

Stage 2—production of materials. At this point, work began on the development of both the instructor's guide and the videos. Terry Dale, ESL/math specialist and co-author of Center for Applied Linguistics mathematics/language series, *English Skills for Algebra*, developed the introductory material and the ESL section of the *Guide* while Maria Maspons, Professor of Mathematics at Miami–Dade Community College supervised and wrote much of the math part. Acting as consultant was Gilberto Cuevas, Associate Professor of Mathematics at the University of Miami, noted researcher in the field of mathematics/language education. M-DCC mathematics professor Candido Sanchez undertook the preparation of the "Glossary Applications" appendix of the *Guide*, a revised

version of the Glossary in *English Skills for Algebra* for it was felt necessary to produce a more "user friendly", yet rigorous, set of explanations for the ESL teacher. As mentioned above, the *Guide* parallels the classroom text, *English Skills for Algebra* in maintaining the following structure:

I. Numerical and Algebraic Expressions
II. Equations and Inequalities
III. The Language of Word Problems
IV. Definitions and Properties
V. A Glossary of Basic Algebra

The *Guide* is in two parts: one addressed to the algebra instructor, the other to the ESL instructor.

What follows is a breakdown of the five Units with a brief description based on our materials in the *Instructor's Guide* :

I. Numerical and Algebraic Expressions

Unit 1 is divided into two sections—*Section A: Working with Numerical Expressions* and *Section B: Working with Algebraic Expressions.* Each section contains listening, speaking, reading and writing exercises which show students how numerical and algebraic expressions are pronounced and read in English.

Throughout Unit 1, emphasis is placed on recognizing the different ways numerical and algebraic expressions (written in symbols) can be said and read in English. Unit 1 can be thought of as the "warm-up" unit for the other units in *English Skills for Algebra.* The algebra content, typically found in algebra textbooks, is minimal. The unit is basically language practice with the vocabulary and phrasing upon which students will begin to build knowledge of basic algebraic concepts and processes.

II. Equations and Inequalities

Unit 2, is quite different from Unit 1. Unit 1 is structured much like a unit of language activities that uses mathematics content. The structure of Unit 2 is roughly the opposite: it contains basic algebra exercises written with a "language slant." Hence, there is more mathematics in Unit 2 than in Unit 1 and the mathematics content of Unit 2 activities is more complex. The goal of Unit 2 activities is to provide students with opportunities to practice the language they would use in math class to explain the processes involved in solving linear equations and inequalities in one variable. The only way students can learn this particular math language is to learn to use it as they go through each step in the process. The language used cannot be separated from the algebra. They must be learned together.

III. The Language of Word Problems

Solving words problems is one of the most difficult tasks facing students of algebra. The very nature of the task requires students to integrate knowledge of algebra with language skills. Unit 3 attempts to focus on the language skills needed for solving word problems as a means through which the mathematical processes required for solutions are expressed.

The activities in Unit 3 are organized in a set of nine general steps (as listed in the *English Skills for Algebra* TABLE OF CONTENTS) that can be followed to solve any word problem. The exercises concentrate on techniques students can use to learn how to read and understand information about the problem situation and then to translate those pieces of information into a mathematical representation of the problem.

IV. Definitions and Properties

The goal of Unit 4 is to give students an opportunity to analyze the meaning and application of a select number of definitions and theorems used in algebra. Students will recognize the definitions and theorems as the items generally found in boxes or bold print in their algebra textbooks.

Probably an instructor's decision to use Unit 4 in his/her ESL classes will depend almost entirely on his/her background in mathematics and algebra. Unit 4 is the unit of *English Skills for Algebra* that most closely resembles an algebra textbook.

V. A Glossary of Basic Algebra

Unit 5 presents definitions and explanations for each glossary entry in appropriate mathematical terms which also include examples and cross-references that expand the short, "cut-and-dry" presentations typical of many algebra textbooks. The goal of the Glossary is to give beginning students the added information they often need to interpret the precise, non-redundant language used in algebra to explain terms, concepts and processes.

Production of the videos. The Media Productions Center of the College assumed the leading role in the pre-production, production and post-production support for developing the supplementary videos: *Introduction to the Math-Language Approach* and *Using English Skills for Algebra in Your Classroom,* assisted by project math and ESL specialists who provided technical and content support.

Introduction to the Math-Language Approach and *Using English Skills for Algebra in Your Classroom* are high quality products with an emphasis on excellence, that were developed with limited grant funding.

The goals associated with the production of the videos were three-fold:

• The supplementary videos can enhance teacher awareness of both *English Skills for Algebra* and the *Instructor's Guide to English Skills for Algebra* by using a medium which can effectively introduce algebra and ESL teachers unfamiliar with the language/math approach in a positive, yet concise manner. Additionally, because of the immediacy of video and its ability to maintain an individual's interest by communicating through various senses to the viewer, it is believed that such an approach is the best vehicle to introduce the uninitiated to this innovative, promising curriculum.

• By providing a low-cost alternative to hitherto indispensable workshops, the *Instructor's Guide*, together with the videos, *Introduction to the Math-Language Approach* and *Using English Skills for Algebra in Your Classroom* , can enhance dissemination of a curriculum developed under a previously funded federal project. This approach not only has the effect of maximizing federal funding dollars but equally important, has made the materials more easily accessible to teachers who otherwise would not have known about the math language approach.

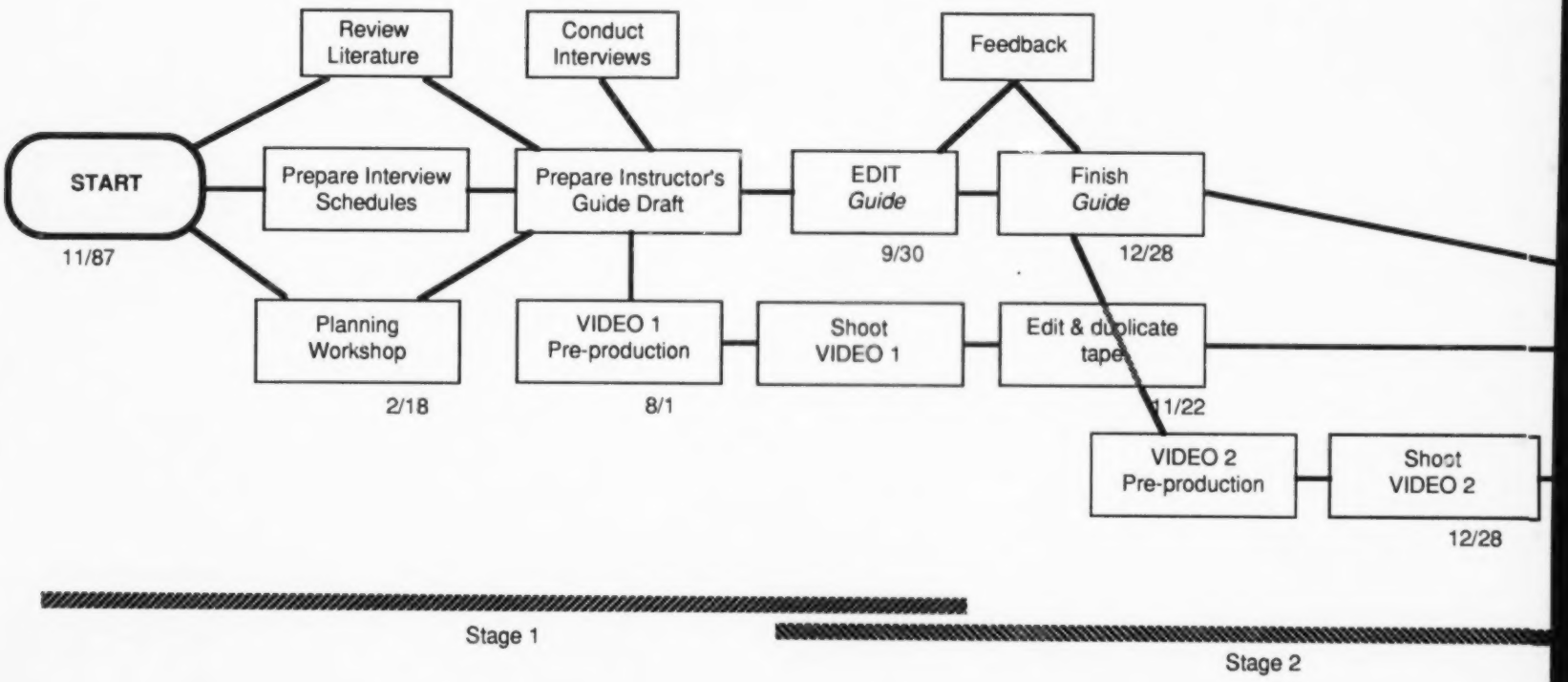
• Provide the teacher with basic strategies and suggestions for classroom implementation and management in the use of *English Skills for Algebra* and *Instructor's Guide to English Skills for Algebra* in a way that would supplant, to some degree, the human contact elements of a workshop experience. Copies of *Introduction to the Math-Language Approach* and *Using English Skills for Algebra in Your Classroom* are attached to this report.

Stage 3—pilot program. At this stage the newly produced materials, the *Instructor's Guide* and the videos were piloted in classroom situations. Sixteen ESL and Algebra instructors were selected to introduce the math-language approach into their teaching capabilities. Eight of these were algebra teachers, the other eight ESL teachers. From each of these two groups, one-half were taught the math-language teaching approach by attending a series of day long workshops conducted by the Center for Applied Linguistics. The other four instructors from each group were introduced to this approach by the new video and instructed in application of the approach through the *Instructor's Guide.*

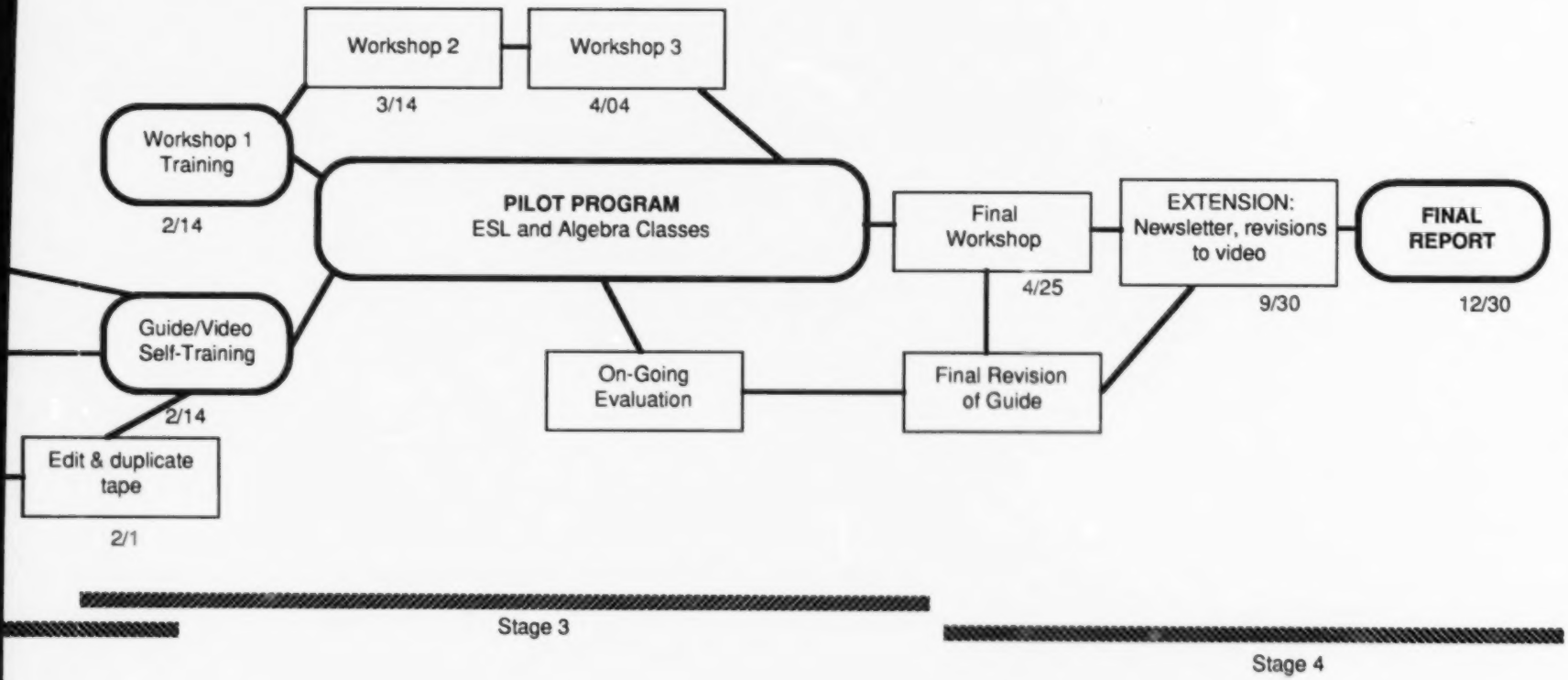
Stage 4—evaluation and revision. An evaluation of the efficacy of using only the video and guide, as opposed to the current method of workshop training was designed by Maria Maspons. Instructor and student impressions of the new material, its application and its usefulness were gathered and analyzed. The results of these evaluations appear in Section E, "Project Results."

Extension. A three-month no-cost extension (July 1–September 30) was requested (and subsequently approved) in order to finish revisions to the *Instructor's Guide* , finish the evaluation, and re-shoot portions of video #2.

M-DCC/FIPSE PROJECT 1988



M-DCC/FIPSE PROJECT 1989



Overview of Principal Participants

Miami-Dade Community College is a publicly supported community college primarily serving Dade County, Florida, at four major campuses and several outreach centers. Through an open door admissions policy, Miami-Dade provides more than 100,000 students with diverse instructional programs designed to prepare them for upper division colleges and universities or entry into a variety of careers. One of the largest community colleges in the nation, Miami-Dade was ranked the number one community college by the Community College Leadership Program at the University of Texas.

The Center for Business and Industry (CBI) of M-DCC's downtown Wolfson Campus provides quality controlled, customized training programs for business, government, special-need groups and the public in general. Selected Miami-Dade faculty and administration serve as the CBI's consultant team in the development of curricula and programs. The CBI is the broker among all departments college-wide and the local community, as well as for several educational programs sponsored abroad.

The Center for Applied Linguistics (CAL) is a private, nonprofit organization (501.C.3) engaged in the study of language and the application of linguistics to educational, cultural and social concerns. It is the leading resource organization of its kind, working to solve language problems in a variety of contexts.

CAL was established in 1959 as an autonomous program of the Modern Language Association and incorporated as an independent organization in 1964. Its goals are to improve the teaching of English and other languages and to incorporate the findings of the language sciences into social and educational policy, nationally and internationally. CAL accomplishes these goals through research, information collection, analysis, and dissemination, the development of teaching and scholarly materials, conference sponsorship and advisory activities including technical assistance and participation in language policy formulation.

Alan Kobrin, project director with CBI, has over 20 years of broad-based experience in management, communications and education. His teaching experience includes science instruction, adult education, ESL and Portuguese instruction in the United States and in South America and Africa. With an educational background in psychology, anthropology, and communications and many years of intercultural living and working experience, Mr. Kobrin has developed courses and lectured on language-learning, music, and photography. An award-winning photographer, photojournalist and radio broadcast professional, Mr. Kobrin has also produced multi-media training and educational materials.

Mr. Kobrin's responsibilities as project director included planning, budgeting, staff and faculty management, as well as supervision of all facets of the project. Specific duties also included serving as editor for the *Instructor's Guide*. Further, he was in charge of the desktop publishing of the *Guide* from initial drafts to its presentation form.

Terry Dale received her bachelor's degree in Spanish from Georgetown University and her M.A.T. in elementary education, with a specialization in

bilingual education, from Trinity College. She is presently a doctoral candidate in applied linguistics at Georgetown.

She has worked in language and linguistics since 1971. Currently, she teaches English as a Second Language at the Arbutus ESOL Center of Baltimore County Public Schools and is an independent educational consultant to several institutions, including the Center for Applied Linguistics and the University of Miami. She has served as administrator of several Federal programs addressing a wide range of educational concerns. A major portion of her work with CAL has centered around the math-language issue, and she has authored several works on the subject.

As the project's Senior ESL professional and math-language specialist, Terry was a writer and consultant to the video project, authored the introductory section of *The Guide* and the part for use in the ESL classroom, and conducted two training workshops. She also assisted the project director with the final evaluation and report on the project.

Maria Maspons, Ph.D., the project's mathematics specialist/trainer, is a professor of mathematics at the M-DCC's Wolfson Campus. She has taught all levels of mathematics courses and served as chair of the math department at Wolfson's InterAmerican Center. She participated in a major project of the College Board to upgrade mathematics education in the U.S. and has authored a number of research papers on math and algebra instruction.

Dr. Maspons served as the senior mathematics consultant for CAL's *English Skills for Algebra* and for the mathematics section of *The Guide*, provided assistance to the producer of the companion video, and conducted training workshops in the second stage of the project.

Gil Cuevas, Ph.D., senior mathematics-language consultant for the project, is an associate professor of mathematics education at the University of Miami. He was a consultant for *English Skills for Algebra* and served as the director of the "Second Language Approach to Mathematics Skills Project", a program designed to develop teacher training materials for bilingual education programs for limited English proficient and bilingual students, grades K through 12.

Dr. Cuevas was formerly an assistant director and teacher trainer of the University of Miami National Origin Desegregation Assistance Center. His duties included mathematics, computer and ESL training of bilingual and ESL teachers in 14 states.

He has authored numerous publications and presentations on teaching mathematics and computer literacy to limited English proficient students.

Candido Sanchez is a professor of mathematics at the Wolfson Campus of M-DCC, where he was recently named Arts & Sciences Professor of the Year. He holds a master's degree in mathematics education from the University of Maryland, an M.A. in math from Notre Dame and a bachelor's degree in electrical engineering from the University of Miami.

Candido began teaching math at the secondary level in 1963. He joined the math faculty at Florida International University in 1972 and moved to M-DCC's Wolfson Campus in 1976. He has also taught Spanish, public administration, educational administration and accounting classes at the adult education and university levels. He recently was honored as one of the country's outstanding teaching faculty by the University of Texas Study of Excellence and has been named in *Who's Who in the South and Southwest*.

Candido served as a math consultant and editor for the project and wrote the "Glossary Applications" appendix and many of the "Math Notes."

George Spanos, Ph.D., the project's mathematics language consultant, provided technical advice for the trainer's manual and video, and conducted a workshop on mathematical definitions and properties.

Co-author of English Skills for Algebra, he is a staff development specialist for the UCLA/CAL Center for Language Education and Research. He has been an ESL instructor for several years and was English Department Chair at Soochow University in Taiwan. His Ph.D. work included studies of advanced symbolic and mathematical logic, and he is fluent in English, Modern Greek and Mandarin Chinese.

Curtis D. Curry served as first director of this project. He authored the original proposal, selected staff and set up the administration of the project and was in charge through Stage 1 and the beginning of Stage 2 when he left to become director of the World Trade Institute in Miami. He has also collaborated on the preparation of the final report.

E) PROJECT RESULTS

Evaluation. Much discussion went into the nature and design of the evaluation process. It became necessary to clarify for ourselves that what we would be trying to evaluate was not the materials themselves but rather their ability to substitute for the workshop training program. It was decided for several reasons that we would seek evaluation of instructor attitudes to the math-language approach and to the application of the activities rather than student performance as an indicator of the effectiveness of the training materials.

First of all, performance measure would duplicate what was done in the original CAL project to evaluate the student content materials of the text/workbook, *English Skills for Algebra* ; there would be no such direct link between teacher-training materials and student performance since there would be many intervening variables (teacher's background, experience, etc.). Secondly, it must be noted also that the materials in question were designed to be *supplementary* to any given curriculum; therefore, not only might the curriculum vary from teacher to teacher, the actual material selected and the amount of time spent on a given unit or exercise would vary in accordance to an instructor's needs and would not be controlled. Since one of the principal objectives was to see how the teachers in

the guide/video group, with no outside guidance other that the *Instructor's Guide* and videos themselves, could appropriate for themselves an understanding of the problems and tenets of the the math-language approach and further select and apply materials and exercises from *English Skills for Algebra* adequate to their own needs, it was felt to be imperative that the staff not intervene by specifying what specific materials were to be used. Except for the initial encounter during which all members of the video/guide group received their materials and watched the videos together, the only contact with that group consisted of an occasional memo (sent simultaneously to all members), suggesting that as the semester was moving along they might wish to try out exercises in units they hadn't used as yet. Evaluation procedures and objectives were elaborated principally by Dr. Maspons and are outlined below:

I. Objective

The main objective of this program was to develop a teachers' manual and two video tapes which would be used to help mathematics and language teachers implement the integrated approach developed in a previous grant by CAL.

This manual and the tapes have the purpose of substituting whenever necessary the training workshops which have so far been used to disseminate this language and mathematics program.

The manual presents a review of the rationale upon which this program is based and provides the teacher with ideas, techniques and suggestions for its implementation.

Program#1 reinforces the rationale underlying this program and further serves as a marketing tool for its successful distribution and integration. A number of the specific problems facing language minority students are dealt with in this tape.

Program#2 offers a variety of lesson plans and uses of the curriculum, based upon the ideas, techniques and suggestions presented in the first tape.

II. Method

The group consisted of 15 ESL and mathematics instructors (Of the 16, one had to leave in the middle of the program without time to be replaced) from Miami-Dade Community College and Barry University. Six of the 15 participants were assigned to attend four workshops where the materials were presented to them and they could give feedback and participate in discussions. The remaining nine instructors were introduced to the program solely by means of the two video programs and the *Instructor's Guide*. The purpose of employing the different approaches outlined above was to investigate the comparative usefulness of the "workshop approach" versus the "manual and video tape approach." The two groups were given questionnaires at several stages: at the beginning of the project, at various times during the project, and at the conclusion of the project. Instructors of both groups regularly

reported which materials they had been using in the classroom during a given period. Care was taken that the groups would not communicate with one another.

III. Results

An analysis of the results of the questionnaires produced the following:

1) The two groups were able to incorporate the materials into their classes on a consistent basis;

2) Both groups demonstrated interest and understanding in the use of the materials;

3) Responses indicated that participants felt that such a program was very useful if not necessary for the improvement of postsecondary mathematics education (See Tables I and II).

IV. Participants' Recommendations

The group introduced to the "manual and video tape approach" made suggestions as to a number of minor technical weaknesses in the video programs. The flaws consisted of scenes where the material was presented in a somewhat artificial manner. The group made a number of suggestions to improve upon those perceived weaknesses. There were no specific recommendations to the *Instructor's Guide* and there was total consensus to its format and effectiveness.

Although no specific questions were asked about *English Skills for Algebra* , there were a number of recommendations for the CAL text.

1) Both groups suggested that the math-language approach as used in *English Skills for Algebra* be applied to the teachings of topics such as geometry and graphs.

2) Both groups indicated that the binders which contained the materials were unduly burdensome and cumbersome.

   Note: This has since been resolved with the publishing of the book by Prentice-Hall. The *Instructor's Guide* binders are much more compact and thus not cited as cumbersome.

3) Suggestions were also made concerning the sequence of topics in *Instructor's Guide* introduced in Units 1 and 2. For example, a number of participants stated that the materials should follow the sequence in which they are normally taught in the classroom (i.e., radicals should not precede addition and subtraction).

Suggestions. Several salient recommendations came out of our efforts, both from within the staff of the project and from the pilot program participants.

- Given the tight schedules that most participants had, it was felt that an appropriate place for students to work more extensively on their math-

language activities would be in a special math-language laboratory, set up and operated jointly by the math and ESL departments.

- The production of similar math/language texts for other math levels or an even more generic approach to the Language of Concept and Design in English are possible offshoots.
- Math or conceptual glossaries could be written to address the number of false cognates that exist among certain languages, or to address specific bilingual issues.
- It was felt that the first video along with the *Math-Language Bulletin* could serve as dissemination not only to the expected target group of math and ESL teachers, but could well be of interest to curriculum developers, administrators, and legislators.

Discussion of Results. Hindsight has shown us a number of ways that the project might have been improved. Some of this is our own observations and some came from the participants of the pilot program. Time was the most frequent problem. Teachers felt that until some changes might be made in the curriculum to include math-language activities, they were limited in how many of the activities could be incorporated during the class. However it was felt that this was partially compensated for by students who in many cases worked on their own time. The amount of time that required to produce the training materials was apparently underestimated; this was especially true of the phases of editing and re-writing, and of video production as well. One of the direct results of this was the necessity to postpone slightly the beginning of the pilot program. We can see now that the pilot program (training) would well have benefitted from having begun in the fall semester and from a longer duration (two semesters). The material was new to all of the instructors, and the difficulties of fitting supplementary exercises into an already crowded syllabus might well have lessened in a second semester's trial, thus allowing a broader usage of the materials and a less harried and more complete appraisal of the results of the training program.

F) SUMMARY AND CONCLUSIONS

The main goals of our project were two-fold: 1) to make more educators aware of the problems posed by an ever-increasing number of limited English proficient students in our math classrooms by highlighting the role language plays in the learning and teaching of mathematics and the concept-building process in general; and 2) to facilitate access and use of recent materials developed within the math-language approach (specifically, CAL's text/workbook, *English Skills for Algebra*) which seek to integrate the teaching of language skills with the communication that takes place in the math classroom.

One of our main concerns was that algebra teachers and ESL teachers differed significantly in their implementation of *English Skills for Algebra* in their classrooms. As the primary focus in the ESL classroom is on learning English, ESL instructors tend to focus on vocabulary, grammar and syntax while de-emphasiz-

TABLE I

WORKSHOP

QUESTION	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
- In general there is a need to improve postsecondary education in the area of mathematics.	66%	17%	17%	0%	0%
- The need to improve postsecondary mathematics education is critical to ethnic and racial minorities.	83%	0%	17%	0%	0%
- There is a unique register of English, a mathematics register, which needs to be mastered before students can be successful in mathematics classes.	67%	33%	0%	0%	0%
- Lack of proficiency in the academic language of mathematics is a reason for not succeeding in mathematics courses.	17%	67%	0%	17%	0%
- Language and mathematics instruction could be integrated in the mathematics classes.	50%	33%	0%	17%	0%
- Language and mathematics instruction could be integrated in the language classes.	33%	67%	0%	0%	0%
- A strong relationship exists between language proficiency and achievement in mathematics.	50%	17%	17%	17%	0%
- Some mathematical background will be helpful to the language instructor who wishes to integrate mathematics into the language classroom.	67%	33%	0%	0%	0%
- Some linguistic background will be helpful to the mathematics instructor who wishes to integrate language into the mathematics classes.	67%	33%	0%	0%	0%
- Minority students could benefit from supplemental language activities which focus on mathematics content.	83%	0%	17%	0%	0%

TABLE I (continued)

QUESTION	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
- Math instruction for minority students should follow an approach which integrates math skills and language skills.	17%	67%	0%	17%	0%
- Opportunities should be provided to minority students to interact with their classmates and teachers in the mathematics classes.	67%	17%	17%	0%	0%
- Opportunities should be provided to minority students to interact with their classmates and teachers in the language classes.	83%	17%	0%	0%	0%
- The materials and teaching approach developed for this purpose minimize the opportunities to teach minority students the mathematics register.	17%	83%	0%	0%	0%
- Minority students should be able to verbalize mathematical concepts and processes if they have truly learned them.	17%	67%	0%	17%	0%
- The cooperative instructional arrangement recommended in these materials encourages the participation of all students.	67%	33%	0%	0%	0%
- These materials are helpful in mastering the mathematics register.	17%	83%	0%	0%	0%
- This math-language approach can supplement and enrich mathematics and language instruction.	67%	33%	0%	0%	0%
- The goal of these materials is to offer students numerous opportunities to practice the language of mathematics.	50%	33%	17%	0%	0%
- Critical factors for success in mathematics are knowledge and experience.with mathematical concepts and processes.	50%	33%	17%	0%	0%

TABLE II

MANUAL AND VIDEO PROGRAMS

QUESTION	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
- In general there is a need to improve postsecondary education in the area of mathematics.	67%	33%	0%	0%	0%
- The need to improve postsecondary mathematics education is critical to ethnic and racial minorities.	33%	56%	11%	0%	0%
- There is a unique register of English, a mathematics register, which needs to be mastered before students can be successful in mathematics classes.	56%	44%	0%	0%	0%
- Lack of proficiency in the academic language of mathematics is a reason for not succeeding in mathematics courses.	44%	56%	0%	17%	0%
- Language and mathematics instruction could be integrated in the mathematics classes.	22%	78%	0%	17%	0%
- Language and mathematics instruction could be integrated in the language classes.	22%	67%	11%	0%	0%
- A strong relationship exists between language proficiency and achievement in mathematics.	11%	56%	22%	11%	0%
- Some mathematical background will be helpful to the language instructor who wishes to integrate mathematics into the language classroom.	33%	67%	0%	0%	0%
- Some linguistic background will be helpful to the mathematics instructor who wishes to integrate language into the mathematics classes.	22%	57%	22%	0%	0%
- Minority students could benefit from supplemental language activities which focus on mathematics content.	33%	56%	11%	0%	0%

TABLE II (continued)

QUESTION	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
- Math instruction for minority students should follow an approach which integrates math skills and language skills.	33%	67%	0%	0%	0%
- Opportunities should be provided to minority students to interact with their classmates and teachers in the mathematics classes.	44%	56%	0%	0%	0%
- Opportunities should be provided to minority students to interact with their classmates and teachers in the language classes.	44%	56%	0%	0%	0%
- The materials and teaching approach developed for this purpose minimize the opportunities to teach minority students the mathematics register.	44%	33%	33%	0%	0%
- Minority students should be able to verbalize mathematical concepts and processes if they have truly learned them.	44%	56%	0%	0%	0%
- The cooperative instructional arrangement recommended in these materials encourages the participation of all students.	56%	33%	11%	0%	0%
- These materials are helpful in mastering the mathematics register.	56%	33%	11%	0%	0%
- This math-language approach can supplement and enrich mathematics and language instruction.	56%	44%	0%	0%	0%
- The goal of these materials is to offer students numerous opportunities to practice the language of mathematics.	44%	56%	0%	0%	0%
- Critical factors for success in mathematics are knowledge and experience with mathematical concepts and processes.	56%	44%	0%	0%	0%

ing cognitive and problem-solving skills. Algebra instructors, on the other hand, place primary emphasis on more complex algebraic operations. By developing the *Instructor's Guide* and the videos, our project addresses the need for providing distinct methodologies for use by the ESL teacher who wishes to integrate mathematics-based activities into the classroom, as well as for the mathematics teacher who desires to incorporate a "language-of-math" component into the algebra classroom. The training materials were designed to aid the ESL instructor through the maze of mathematical concepts while at the same time offering the algebra teacher strategies for incorporating a meaningful linguistic component.

The teacher-training package which we developed effectively meets those goals. This package together with the *Math-Language Bulletin* make it possible to reach not only math and language instructors, but other faculty and administrators as well with the message about the math-language approach, and promotes interdepartmental cooperation to seek curricular and other solutions to the problems.

The project has succeeded in meeting its challenges and proving its hypothesis. It has produced an instructor's guide and two quality videos which enabled a group of teachers to encounter the math-language approach to rapidly incorporate aspects of *English Skills for Algebra* into their classes. The project has shown that the *Instructor's Guide* for *English Skills for Algebra* addresses the questions both math and ESL instructors have with respect to the math-language approach, and facilitates the implementation of the CAL materials and can effectively substitute for workshop training.

G) APPENDICES

- the *Instructor's Guide to English Skills for Algebra*
- CAL's textbook *English Skills for Algebra*
- Video programs #1 and #2
- the *Math-Language Bulletin*

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